Wake measurements of the Unsteady Aero Experiment turbine in the region of a tail vane

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Project Goals

- **Increase knowledge of tail vane aerodynamics**
- **Tie wake measurements in with detailed rotor aerodynamics**
- **Part of DOE Small Turbine Program modeling efforts**

Description

- **Two 3-axis sonic anemometers placed behind rotor at hub height**
- **30 second wind speed data set at 10 Hz in addition to rotor data set**

Wake Measurement Setup

- **0.6D downstream**
- **at 0.02 and 0.49 r/R**
- **Yaw CW from top**
- **Rotor CCW from upstream**
- **Yaw stop at 65º**
- **Nacelle and boom influence**

Wake Research

- **Past wake measurement programs:**
  - **wake models for rotor aerodynamics**
  - **wakes of turbines in arrays**
- **No previous measurements were in typical tail vane region**

Weaknesses of Current Program

- low bandwidth (4/rev max)
- limited wake spatial resolution
- low tip speed ratios
- yaw dynamics not simulated
- turbulence not simulated

Test Matrix

Uw (m/s)	TSR	Yaw Angle									
		0	5	10	15	20	25	30	40	50	60
5.0	7.5	X2	X	X	X	X	X	X	X	X	X
6.0	6.3	X	X	X	X	X	X	X	X	X	X
7.0	5.4	X2	X	X	X	X	X	X	X	X	X
8.0	4.7	X	X	X	X	X	X	X	X	X	X
9.0	4.2	X2	X	X	X	X	X	X	X	X	X
10.0	3.8	X2	X	X	X	X	X	X	X	X	X
11.0	3.4	X	X	X	X	X	X	X	X	X	X
12.0	3.1	X	X	X	X	X	X	X	X	X	X
13.0	2.9	X2	X	X	X	X	X	X	X	X	X
14.0	2.7	X	X	X	X	X	X	X	X	X	X
15.0	2.5	X2	X	X	X	X	X	X	X	X	X
16.0	2.4	X	X	X	X	X	X	X			
17.0	2.2	X2	X	X	X	X	X	X			
18.0	2.1	X	X	X	X	X					
19.0	2.0	X	X	X	X	X					
20.0	1.9	X	X	X							
21.0	1.8	X	X	X							
22.0	1.7	X	X	X							
23.0	1.6	X									
24.0	1.6	X									
25.0	1.5	X									

Current Status

- **Data submitted to RANN for furling models**
- **ASME 2001 Wind Energy paper in progress**